Table 20. Basis for Selection of Stressor Ecosystem Elements.

Stressors	Basis for Selection as an Ecosystem Element
Water Diversions	Diversions cause loss of water, nutrients, sediment, and organisms (entrainment). The transfer of water across the Delta through existing channels may also detour migrating resident, estuarine, and resident fish species from their primary routes. The diversion rate also contributes to reduced water residence time which reduces primary (plant) and secondary (animal) production and standing biomass.
Dams and Other Structures	Dams block fish movement, alter water quality, remove fish and wildlife habitat, and alter hydrological and sediment processes. Other human-made structures may block fish movement or provide habitat or opportunities for detrimental predatory fish and wildlife.
Levees, Bridges, and Bank Protection	Levee, bridge, and bank protection structures inhibit overland flow and erosion and depositional processes that develop and maintain floodplains, and allow stream channels to meander. Levees prevent floodflows from entering historic floodplains, and eliminate or alter the character of floodplain ecosystem processes and habitats. Channelizing floodflows also increases scour or incision and reduces or halts channel meander and oxbow formation. Bridges have a similar, though generally more localized effect.
Dredging and Sediment Disposal	Dredging in Bay-Delta waters may damage aquatic habitat or harm aquatic animals and plants. Channel dredging also contributes to levee instability and steepens channel banks which increases shoreline habitat erosion.
Gravel Mining	Mining sand and gravels from rivers and floodplains may affect natural sediment supply, gravel movement, and sediment deposition. Sand, gravel, and sediment distribution influences the quality of wildlife habitat, abundance of aquatic predators, water quality and fish and wildlife populations. Excessive instream mining could result in riparian corridor instability.
Invasive Aquatic Plants	Invasive aquatic plants may have an adverse effect on native aquatic plants, constrain habitat quality of water ways, require control measures, and impair water conveyance systems and use of fish protective devices such as fish screens.
Invasive Aquatic Organisms	Invasive aquatic organisms may have an adverse effect on the foodweb and on native species resulting from competition for food and habitat and direct predation.
Invasive Riparian and Marsh Plants	Restoration of native riparian and marsh plants and plant communities can be hindered by introduced species which may out-compete or displace native plant species. Non-native plant species may have little value to wildlife and other riparian dependent species.

Table 20. Basis for Selection of Stressor Ecosystem Elements (continued).

Stressors	Basis for Selection as an Ecosystem Element
Zebra Mussel	The zebra mussel has caused enormous damage to water supply infrastructure and natural ecosystems in the eastern United States. It is likely that zebra mussel will appear in California's Central Valley through any one of several means. Therefore, it is highly desirable to have in place a strategy to swiftly contain a localized invasion.
Non-native Wildlife	Introductions of non-native species may adversely affect the survival of native wildlife. Non-native wildlife has greatly altered ecological processes, functions, habitats, species diversity, and abundance of native plants, fish, and wildlife.
Predation and Competition	Unnatural levels of predation and competition may adversely affect populations of fish and wildlife.
Contaminants	Contaminants affect water quality and the survival of fish, waterfowl, and the aquatic foodweb.
Fish and Wildlife Harvest	Fish and wildlife harvest may affect abundance of species or viability of local populations.
Artificial Fish Propagation	Fish hatcheries and other artificial propagation programs (e.g., pen-rearing salvaged striped bass) may adversely affect populations of "wild" fish. Direct effects might be predation on wild fish or competition from artificially-produced fish. Indirect effects may occur from adverse changes in wild population genetics from interbreeding with hatchery fish. Disease may also be transferred from hatchery fish to wild fish.
Stranding	Stranding of juvenile fish and other aquatic organisms was probably a natural environmental event in the historical Central Valley. Today, many stranding events are caused by flood bypasses, construction of levee toe drains, and other anthropomorphic events. Modification to lowland areas and providing escape routes back to larger bodies of water and flowing streams will reduce the mortality related to stranding.
Disturbance	Boating, habitat disturbance, and other negative anthropogenic activities may adversely affect wildlife habitat and species abundance and distributions.

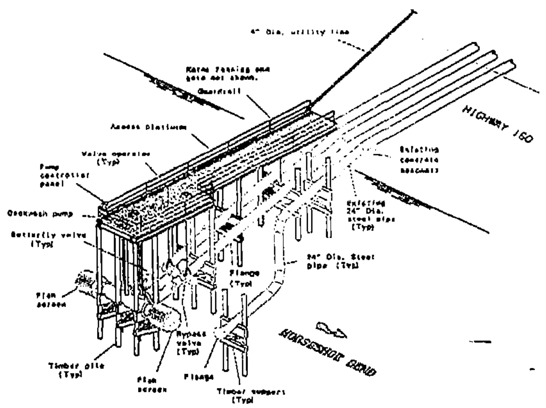
Table 21. Ecological Management Zones in Which Targets and Programmatic Actions to Reduce Stressors Are Proposed

[Note: Refer to Volume II: Ecological Management Zone Visions for information regarding specific targets and actions.]

Stressors	Ecological Management Zone[1]													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Water Diversions	●	●	●	●			●	●	●	●	●	●	●	
Dams and Other Structures			●	●			●	●			●		●	
Levees, Bridges, and Bank Protection	●		●						●			●		
Dredging and Sediment Disposal	●													
Gravel Mining				●	●					●				
Non-native Species	●	●	●	●					●	●	●			
Zebra Mussel	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Predation and Competition	●	●	●							●	●		●	
Contaminants	●	●	●			●			●	●	●	●		●
Fish and Wildlife Harvest	●	●	●	●			●	●	●		●		●	
Artificial Fish Propagation			●	●			●	●	●		●		●	
Stranding	●	●	●				●	●	●	●			●	
Disturbance	●	●												

Ecological Management Zones

[1] 1 = Sacramento-San Joaquin Delta
2 = Suisun Marsh/North San Francisco Bay
3 = Sacramento River
4 = North Sacramento Valley
5 = Cottonwood Creek
6 = Colusa Basin
7 = Butte Basin
8 = Feather River/Sutter Basin
9 = American River Basin
10 = Yolo Basin
11 = Eastside Delta Tributaries
12 = San Joaquin River
13 = East San Joaquin Basin
14 = West San Joaquin Basin



INTRODUCTION

Water diversions are found throughout Central Valley rivers and their tributaries, the Bay and Delta. Water is diverted for irrigated agriculture, municipal and industrial use, and managed wetlands.

Water diversions in the Bay-Delta watershed directly and indirectly affect fish, aquatic organisms, sediments, salinity, streamflow, habitat, foodweb productivity, and species abundance and distribution. The rate of diversion from the Delta affects residence time of water which, in turn, affects primary (plant) and secondary (animal) production.

Factors that relate to the influence that diversions have on the health of the Bay-Delta ecosystem health include diversion rate, the season in which water is diverted, the diversion location, fish species, fish life stage periodicity, and whether the diversion is equipped with adequate fish protection facilities.

In most cases, entrained organisms do not survive. Some diversions have screens that exclude most juvenile and adult fish; however, eggs and larval fish, invertebrates, planktonic plants, organic debris and dissolved nutrients are lost to diversions.

STRESSOR DESCRIPTION

Water diversion in the Bay-Delta and its watershed may vary by water year type and month of the year, and has a wide variety of effects on streamflow, aquatic organisms, habitat, and ecosystem processes. In some cases, diversions on a tributary stream remove so much flow during summer and fall that little or no flow remains in the stream.

Along the mainstem Sacramento River the following diversions exist:

- The Red Bluff Diversion Dam (RBDD) diverts Sacramento River water into the Tehama-Colusa Canal and the Corning Canal.
- The Anderson-Cottonwood Irrigation District (ACID) Diversion Dam diverts water into the ACID canal.
- The Glenn-Colusa Irrigation District's (GCID's) Hamilton City Pumping Plant. With a diversion capacity of 3,000 cubic feet per second (cfs) it is the largest diversion on the Sacramento River.
- Several hundred smaller diversions exist along the Sacramento River, more than 2,000 diversions exist in the Delta, and about 150 diversions exist in the San Joaquin.

The largest diversions have fish screens and require frequent, routine maintenance to provide consistent levels of fish protection. The effectiveness of screens is dependent on may factors, including maintenance, design, and site-specific physical conditions. A well-designed fish screen based on proved technology is effective in reducing entrainment and impingement losses of many species of juvenile fish. Screen retrofits can be fairly inexpensive, especially on smaller-sized diversions.

In the south Delta, the two largest diversions are operated by the State Water Project (SWP) and federal Central Valley Project (CVP). These two large diversions have louvers that guide juvenile fish into bypasses and holding facilities, where salvaged fish are collected and transported back to the Bay and Delta. Many fish are salvaged. Nevertheless, many more are lost to handling, predation and to bypass inefficiency during collection and holding at the fish facilities, or during fish transport. Programs to upgrade these fish protection facilities are ongoing.

Two large fossil fuel power plants are operated in the Bay-Delta, one at Antioch and one at Pittsburg. Each has large, screened intake systems. The screens, however, use 1950s technology and do not effectively screen larvae or small juvenile fish. Although the power plants return the water to the Delta, many entrained larvae and juveniles are killed by mechanical damage or heat stress. Survival rates have been measured only for striped bass and under many conditions, approximately 80% passing through the plant survive.

The Contra Costa Water District has several diversions in the Bay-Delta. They sporadically operate a diversion at Mallard Slough in Suisun Bay. New screens are in place at the new Los Vaqueros diversion on Old River. New screens are being constructed at the Contra Costa Water District Rock Slough intake.

In Suisun Bay and Suisun Marsh, far fewer agricultural diversions exist because of brackish waters. However, many State and privately managed wetlands divert water seasonally from Suisun Marsh sloughs. The larger diversions at Roaring River, Grizzly Slough, and Island Slough are screened. The smaller diversions are unscreened gates, siphons, or pumps. Recently, the Suisun Resource Conservation District (SRCD) and California Department of Fish and Game (DFG) began a program to screen some diversions with self-cleaning, fine-mesh screens.

ISSUES AND OPPORTUNITIES

ENTRAINMENT OF FISH AT PUMPS. The entrainment of fish and other biota in the CVP and SWP pumps and agricultural water diversions in the Delta and tributaries stimulate conflicts among stakeholders. However, it is not clear to what extent entrainment affects the population size of any one species of fish or invertebrate (Diversion Effects on Fish Team 1998). More information on the effects of entrainment will be pivotal in choosing a water conveyance method, because it will help determine to what extent an "isolated facility" can be expected to alleviate any problems. Reducing this uncertainty is also essential to ensure the most efficient allocation of restoration funds because proposed solutions to this problem include potentially tens of millions of dollars spent constructing fish screens and new intake facilities throughout the Bay-Delta system, not all of which may be as effective as intended at reducing population declines (Strategic Plan 2000).

VISION

The vision for water diversions is to reduce the adverse effects of water diversions, including entrainment of all life stages of aquatic species, by installing fish screens, consolidating or moving diversions to less sensitive locations, removing diversions, or reducing the volume of water diverted.

Achieving this vision will assist in the recovery of State- and federally listed fish species, improve important sport fisheries, and improve the Bay-Delta aquatic foodweb.

This vision concentrates on the direct effects of aquatic organism entrainment. Cumulatively, water diversions remove large numbers of young salmon, steelhead, delta smelt, splittail, striped bass, and many other fishes and invertebrates from the rivers, Delta, and Bay.

Approaches to achieving this vision include reducing their adverse effects by removing or relocating high impact diversions. Altering the timing of some diversions would help to reduce losses of aquatic organisms. Installing positive-barrier fish screens would help to reduce losses.

On many Sacramento and San Joaquin rivers and their tributaries, diversions entrain juvenile salmon and steelhead in spawning and rearing areas, and on their migrations downstream toward the ocean. Adequate positive barrier fish screens will protect juvenile salmon and steelhead from being entrained. Positive barrier fish screens can be employed at most of the tributary diversion sites.

Screen upgrades continue to improve screening efficiency for the large diversions along the Sacramento River, such as those of ACID, RBDD, and GCID. The Red Bluff Research Program is studying alternatives, including pumping from the river and returning entrained salmon and steelhead to the river through a bypass system. Positive-barrier screens that move fish through a bypass are also being considered for large diversions such as GCID.

The Delta Fish Facilities Technical Team is focusing on reducing entrainment losses at the south Delta pumping plants through the use of positive barrier fish screens. Salvage facilities at SWP and CVP diversions do not provide adequate fish protection, especially for small, fragile species like delta smelt.

The technical team is currently considering two parallel approaches. The first is to upgrade the screening systems of the existing facilities. The second is to provide an alternative intake location, such as in the north Delta, where entrainment losses would be less and fewer fish would be drawn into the Central and South Delta.

The preferred approach includes construction of a new screened intake at Clifton Court Forebay with protective screening criteria and construction of either a new screened diversion at Tracy with protective screening criteria; and/or an expansion of the new diversion at Clifton Court Forebay to meet the Tracy Pumping Plant export capacity. This approach is designed to improve water supply reliability, protect and improve Delta water quality, improve ecosystem heath, and reduce risk of supply disruption due to catastrophic breaching of Delta levees.

Using self-cleaning cylindrical screens on small Bay-Delta siphons and pump diversions appears feasible. In Suisun Bay and Suisun Marsh, use of either positive-barrier flat screens or conical screens on slough intakes (e.g., Roaring River diversion) has proven effective.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Working with individual diverters would achieve the vision to provide them with alternative sources of water, moving their intakes, revising their diversion schedules, or funding installation of screened intakes.

Efforts to reduce impacts of unscreened diversions in the Bay-Delta and its watershed will involve cooperation among several agencies' screening programs including DFG's Unscreened Diversion Program, Anadromous Fish Screen Program of the CVPIA, and NRCS's Fish Screen Program. Recently, Reclamation Districts 108 and 1004, and Princeton-Cordua-Glenn/Provident Irrigation District and other large diverters are either installing new screens or have begun the engineering needed to install screens. Hundreds of smaller diversions along the river consist of siphons or pumps; most of these are unscreened. The CVPIA Anadromous Fish Screen Program will contribute to the screening of many of these diversions on a cost-share basis. Cooperation will also be sought with agencies having responsibility or authority for dealing with screening diversions, including DFG, DWR, Reclamation, State Water Resources Control Board, NRCS, NMFS, and the U.S. Army Corps of Engineers.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Water diversions are closely linked to other ecosystem elements including processes, habitats, and species. For example, the diversion of large quantities of water in the Delta also results in the diversion of sediments, nutrients, and many lower level organisms in the Bay-Delta aquatic food chain. The management of water in the ERPP study area, particularly the delivery of water to the Delta for export, has altered natural flow patterns and ecological processes that maintain habitats in upstream rivers and tributaries and in the Delta. Entrainment also causes direct and indirect mortality to juvenile fish, eggs and larvae.

OBJECTIVES, TARGETS, ACTIONS, AND MEASURES

Achieve, first, recovery and then large self-sustaining populations of at-risk native species dependent on the Delta, Suisun Bay, and Suisun Marsh.

Enhance and/or conserve native biotic communities in the Bay-Delta estuary and its watershed.

LONG-TERM OBJECTIVE: Eliminate or reduce adverse impacts of the diversion of water to a level of little significance.

SHORT-TERM OBJECTIVE: Construct and screen a new SWP intake to Clifton Court Forebay. Construct a new screened intake at the CVP intake and/or expand the new diversion at Clifton Court to meet Tracy Pumping Plant need. Screen the largest of the remaining unscreened diversions then begin screening the smaller diversions. Develop a science and data based analysis/evaluation process by which to set priorities for screening.

RATIONALE: Storage and diversion of water from Central Valley rivers and streams and from the Delta has produced significant detrimental effects on the ecosystem, including functions such as spawning, rearing, and migration, the processes that create and maintain habitat, habitat, and species that depend on the aquatic habitats. The relocation, consolidation and installation of positive barrier fish screens does not reduce the amount of water extracted, but such actions are encouraged as they will reduce the mortality resulting from the direct entrainment of young fish. The intent of the restoration program is to eliminate loss of fish resulting from the unscreened diversion of water to a level that no longer impairs efforts to rebuild fish populations to healthy levels. Likewise, the potential future relocation of the SWP and CVP intakes and installation of positive barrier fish screens does not reduce the amount of water extracted, but will reduce the mortality resulting from the direct entrainment of young fish and contribute to restoring the ecological functions of the Delta such as food web support, and spawning and rearing habitat.

STAGE 1 EXPECTATIONS: During Stage 1 of the implementation program, all diversions greater than 250 cfs will have been screened, the majority of diversions between 100 and 250 cfs will have been screened, and a process will be in place to set priorities and screen diversion smaller that 100 cfs. During this period, fish populations will exhibit a positive response and increase in abundance.

Establish hydrologic regimes in streams, including sufficient flow timing, magnitude, duration and high flow frequency, to maintain channel and sediment conditions supporting the recovery and restoration of native aquatic and riparian species and biotic communities.

Establish and maintain hydrological and hydrodynamic regimes for the Bay and Delta that support the recovery and restoration of native species and biotic communities, support the restoration and maintenance of functional natural habitats, and maintains harvestable species.

LONG-TERM OBJECTIVE: For regulated rivers in the region, establish scientifically based high-flow events necessary to maintain dynamic channel processes, channel complexity, bed sediment quality, and natural riparian habitats where feasible.

SHORT-TERM OBJECTIVE: Through management of the reservoir pool or deliberate reservoir releases, provide a series of experimental high-flow events in regulated rivers to observe flow effects on bed mobility, bed sediment quality, channel migration, invertebrate assemblages, fish abundance, and riparian habitats over a period of years. Use the findings of these studies to reestablish natural stream processes where feasible, including restoration of periodic inundation of remaining undeveloped floodplains.

RATIONALE: Native aquatic and riparian organisms in the Central Valley evolved under a flow regime with pronounced seasonal and year-to-year variability. Frequent (annual or longer term) high flows mobilized gravel beds, drove channel migration, inundated floodplains, maintained sediment quality for native fishes and invertebrates, and maintained complex channel and floodplain habitats. By deliberately releasing such flows from reservoirs, at least some of these physical and ecological functions can probably be recreated. A program of such high-flow releases, in conjunction with natural high-flow events, lends itself well to adaptive management because the flows can easily be adjusted to the level needed to achieve specific objectives. However, it should be recognized that channel adjustments may lag behind hydrologic changes by years or decades, requiring long-term monitoring. Also, on most rivers, reservoirs are not large enough to eliminate extremely large, infrequent events so these will continue to affect channel form at irregular, often long, intervals; artificial high-flow events may be needed to maintain desirable channel configurations created during the natural events. This objective focuses on flows that are likely to be higher than those needed to maintain most native fish species but that are important for maintaining in-channel and riparian habitats for fish as well as other species (e.g., invertebrates, birds, mammals). Experimental flow releases also will have to be carefully monitored for negative effects, such as encouraging the invasion of unwanted non-native species.

STAGE 1 EXPECTATIONS: Studies should be conducted on five to 10 regulated rivers in the Central Valley to determine the effects of high-flow releases. Natural floodplains should be identified that can be inundated with minimal disruption of human activity. Where positive benefits are shown, flow recommendations should be developed and instituted where feasible.

RESTORATION ACTIONS

The general target is to reduce the adverse effects of water diversion so that the diversion of water, in conjunction with other restoration actions, does not impair other restoration efforts needed to restore ecological health to the Bay-Delta system.

The following activities would help to achieve this vision:

- Widen the area of concern of the Anadromous Fish Screen Program's multiagency policy level and management team for unscreened diversions which is composed of representatives from the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), U.S. Bureau of Reclamation (Reclamation), DFG, California Department of Water Resources (DWR), and U.S. Natural Resources Conservation Service (NRCS) districts.
- Finish the development of the priority system to install positive-barrier fish screens on all diversions of more than 100 cfs in the upper Sacramento River and all diversions in tributary streams with salmon and steelhead populations by providing funding support to DFG and CVPIA screening programs.
- Construct and test a pilot screening facility in the south Delta adjacent to the Tracy Fish Facility to test a 500 cfs positive-barrier fish screen and collection system.
- Construct new screened intakes at Clifton Court and the Tracy Fish Facility; and/or expand the diversion at Clifton Court to accommodate the needs of the Tracy Pumping Plant and fish-holding facility.
- Support completion of research at the Red Bluff Research Program.
- Assess the effectiveness of test cylindrical screens at DWR siphon diversions on Sherman Island.
- Screen small diversions in Suisun Marsh, focusing on Montezuma and Suisun Sloughs.
- Continue research on fish behavior relative to screening (University of California, Davis Treadmill Study).
- Continue research on fish screening and related facilities design and operations.
- Coordinate research and testing of the various screening programs among resource agencies.
- Develop a long-term screening program plan in cooperation with DFG, USFWS, NMFS, irrigators, and other stakeholders.
- Screen small siphon and pump diversions in the Delta, mainstem rivers, and lower tributaries.
- Develop an incentive plan to encourage local diverters to consolidate smaller diversions where possible to increase the cost-effectiveness of screening.
- Consider an upgrade to existing screens at PG&E's Pittsburg power plant and Contra Costa Water District's Mallard Slough diversion with positive-barrier fish screens.
- Provide alternative sources of water to diversions, where possible, in lower portions of tributaries

and agricultural lands and managed wetlands along rivers and in the Delta and Suisun Marsh.

MSCS CONSERVATION MEASURES

The following conservation measures were included in the Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions that would help achieve species habitat or population targets.

- Consistent with CALFED objectives, operate diversions to minimize adverse affects of diversion on longfin smelt during the peak spawning period (January - March).
- Protect the Sacramento and San Joaquin river and tributary channels from flow disruptions (e.g., water diversion that result in entrainment and inchannel barriers or tidal gates) for the period February 1, to August 31.
- Reduce the loss of young splittail to entrainment into south Delta pumping plants.
- To the extent practicable, reduce the loss of splittail at 1800 unscreened diversions in the Delta.
- Design and construct a new intake screen system at the entrance to Clifton Court Forebay that minimizes potential involvement of splittail and connect intakes of Tracy Pumping Plant to Clifton Court Forebay.

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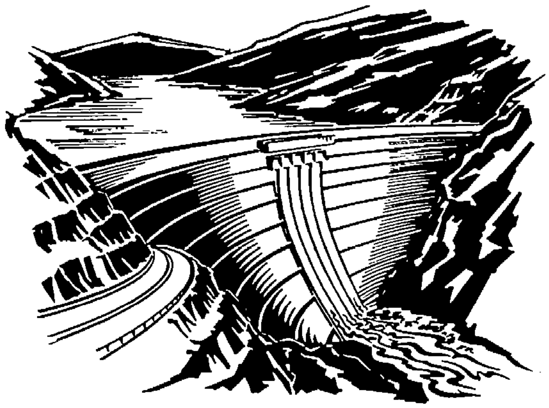
Multi-Species Conservation Strategy. 2000. CALFED Bay-Delta Program, Programmatic EIS/EIR Technical Appendix. July 2000.

The Resources Agency. 1989. Upper Sacramento River fisheries and riparian habitat management plan. Sacramento, CA.

Strategic Plan for Ecosystem Restoration. 2000. CALFED Bay-Delta Program, Programmatic EIS/EIR Technical Appendix. July 2000.

◆ Dams and Other Structures



Introduction

Dams and other human-made structures come in various forms, from the largest dam (Shasta), to small weirs on tributary streams. Dams stop downstream water flow and capture sediment derived from erosion in the upper watersheds. The captured water backs up to create a reservoir. Seven major dams restrict streamflows from entering the Bay-Delta.

Diversion dams exist throughout the watershed of the Sacramento-San Joaquin rivers and Bay-Delta. Larger weirs are located along the Sacramento River at the Yolo, Sutter, and Sacramento bypasses. Small weirs can be found on most upper watershed tributaries.

Dams and other human-made structures act as stressors on ecosystem processes, important habitats, and species in aquatic ecosystems. For example, dams and their associated reservoirs block fish migration, alter water quality, remove fish and wildlife habitat, and alter hydrological and sediment processes. The construction, operation, and maintenance of these structures in the Central Valley have contributed to the decline of many species.

Stressor Description

Dams in any form block or hinder upstream and downstream migrations of anadromous fish and hinder downstream transport of sediment. Larger dams completely block anadromous fish migration. These large dams resulted in the loss, and in some cases extinction, of local salmon and steelhead populations (Mills et al. 1996).

Many moderately sized diversion dams, such as Red Bluff Diversion Dam (RBDD) and Anderson-Cottonwood Irrigation District (ACID) Diversion Dam, contain fish ladders to allow fish passage. Some dams, such as Capay Dam on Cache Creek and Solano Dam on Putah Creek, do not.

Small diversion dams are generally constructed to seasonally divert water for irrigation. Although many have been fitted with ladders to allow fish passage, many are technologically outdated and only marginally effective. Often, salmon and steelhead can negotiate the fish ladders, but other species, such as American shad, green sturgeon, and white sturgeon, cannot. In some cases, fish ladders delay adult salmon and steelhead from reaching upstream spawning grounds or downstream migrating juvenile salmon and steelhead.

In high-flow years, water flows from the river into the bypasses and downstream to return to the river or Delta. In such cases, adult salmon and steelhead may migrate upstream through the bypasses and become blocked below the weirs opposite the river. A similar situation occurs in the Sacramento Ship Channel. Blockage and delay of steelhead and winter-run salmon are of particular concern because the fish usually migrate upstream during the winter and spring high-flow periods.

Larger irrigation returns in wetter years have relatively high flows that may attract anadromous fish. Fish attracted to these returns may become lost or delayed. The Colusa Basin drain, which enters the Sacramento River near Knights Landing, is an example of an irrigation return that is known to attract adult salmon.

Issues and Opportunities

Opportunities for Rivers: Mimic natural flow regimes through innovative methods to manage reservoir releases. There is underutilized potential to modify reservoir operations rules to create more dynamic, natural high-flow regimes in regulated rivers without seriously impinging on the water storage purposes for which the reservoir was constructed. Water release operating rules could be changed to ensure greater variability of flow, provide